CLIMATE INFORMATION APPLICATION FORENHANCING RESILIENCE TO CLIMATE RISKS

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Despite significant improvements in the prediction and monitoring of climatic phenomena on a wide range of scales in the last decade, extreme weather and climatic events continue to cause much destruction and loss of lives. In the last 10 years (1994-2003), damage associated with floods, drought and windstorms in South and Southeas Asia alone amounted to over US$ 31 billion, with 24,336 deaths (EM-DAT, http://www.em-dat.net). The scientific advance in prediction and monitoring of extreme weather and climate needs to be complemented with improved strategies for communicating risk and uncertainty in forecast information, if this scientific skill is to be applied in mitigating disasters.

The application of climate information of various time scales for natural disaster mitigation and prevention has increasingly received attention in recent years. The World Meteorological Organization (WMO), in its Long Term Plan (2000-2009) for Region II (Asia), has prioritized climate information application, along with climate monitoring and research, and improvement of warning systems and public weather services, for natural disaster reduction.

1. Climate Information Products in the Tropics

The second half of the 20th century saw enormous advances in weather and climate prediction. Satellites, aircrafts, balloons, and moored and drifting buoys, in addition to surface networks established in many countries, provided a near-global coverage of the atmosphere and the ocean surface. The development of computer models of the atmosphere-ocean system, integrating observations from these observing systems, provided increasingly accurate weather forecasts. Late in the 20th century, the skill in monitoring and predicting the onset and development of the El Niño Southern Oscillation (ENSO) has dramatically increased, which has greatly contributed to the advancement of the science of seasonal forecasting.

In Asia, real-time automated and/or manned weather observations, radar echo maps, satellite imageries, wind profilers, lightning detection systems, and real-time weather maps and meso-scale numerical guidance products are used by National Meteorological Services (NMSs) in generating weather forecasts. Many of the smaller NMSs use forecast products from other generators in the region or internationally, such as Regional Specialized Meteorological Centers (RSMC), the WMO Global Telecommunications System (GTS), European Center for Medium-Range Weather Forecasts (ECMWF), Japan Meteorological Agency (JMA), United Kingdom Meteorological Office (UKMO), the US National Weather Service, German Meteorological Service (Deutscher Wetterdienst), Meteorological Service of Canada, and the Bureau of Meteorology Australia (BoM). Also, NMSs of neighboring countries share information through existing agreements, particularly over bordering regions.

The range of climate information products now available in the Asian region include:

- Weather forecast, with a lead time from 3-5 days
- Extended weather forecast, with 5-10 days lead time
- Medium-range forecast (sub-seasonal), with 20-25 days lead time
- Seasonal forecast, with a lead time of 1 month and beyond

The skill provided by these forecasts is shown in Figure 1.

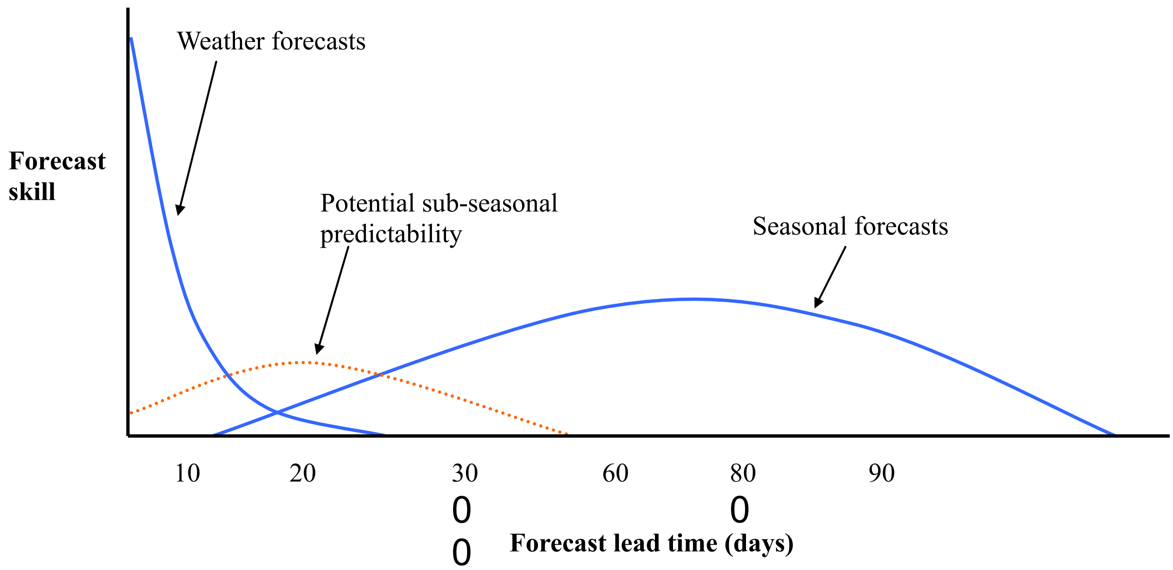

Figure 1. Skill and lead times of climate information products

Weather forecasts have the highest skill for lead times less than 5 days. Forecast skill dramatically decreases beyond 10 days into the future. Emerging sub-seasonal forecasts, initially thought of as having no skill, are now able to provide increased confidence beyond 15 days. Seasonal forecasts, which are probabilistic, have, at best, half the skill of weather forecasts.

The sub-seasonal forecast is a combination of the medium-range ensemble prediction system and the seasonal forecasting system. It therefore contains features of both systems and, in particular, is based on coupled ocean-atmosphere integrations, as is the seasonal forecasting system. ECMWF generates every two weeks experimental monthly (sub-seasonal) forecasts, based on an ensemble of 51 coupled ocean-atmosphere integrations, with a length of 32 days. However, potential predictability generally decreases sharply in the last two weeks of the forecasts (Vitart, 2004).

Where the ECMWF monthly forecasts generally fail (from the 20th day onward), the sub-seasonal forecasting scheme[1] developed by Dr. Peter Webster, Georgia Institute of Technology, for Bangladesh, has made a breakthrough. In spite of model unavailability for guidance in model development, Dr. Webster has successfully developed an empirical method that takes into consideration the mesoscale oscillation of low frequency periods of wet and dry spells within the monsoon season in Bangladesh. The scheme uses Bayesian statistical technique, with predictors from MISO diagnostics. This experimental forecast, issued every 5 days, provides a lead-time of 20-25 days. Figure 2 shows a sample of the 20-day rainfall forecast over the Ganges Plain for the summer 2002, and the level of skill achieved by the forecast model.

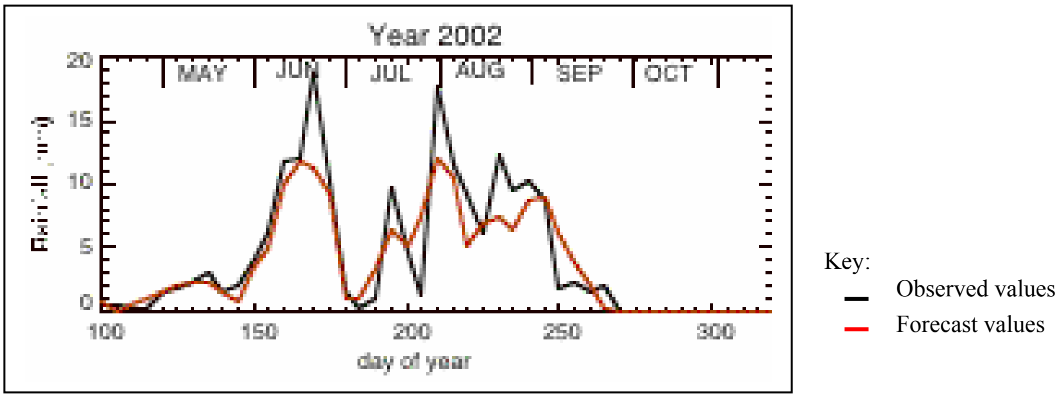

Figure 2. The 20-day rainfall forecast for the Ganges Plain, April-September 2002

Despite the advances made in modern numerical weather prediction, and contrary to the science of forecasting, weather forecasting in Asia continues to be essentially deterministic, due to public pressure for an accurate forecast. To the public, probabilistic forecasts carry little meaning, and hence require translation into deterministic messages that include information on risks associated with the forecasted event. Considering the temporal and spatial specificities of the forecasts, it is difficult, if not appropriate, for NMSs to meet this expectation. Risks are to be determined by the users, based on the forecast information received. This is a role that intermediary users of climate information can play – the translation of the forecast information into sectoral impacts and user response options, for communication to and application by end users.

2. State of Climate Information Application in the Tropics

2.1 Weather Scale

Weather forecasts provide 3-5 days lead time, sufficient for securing lives. Warning message construction and dissemination are, however, critical in getting authorities and communities to take advantage of the lead time offered by weather forecasts.

[1] The medium-range forecast model is part of the three-tiered overlapping precipitation forecasting scheme developed by Dr. Peter Webster under the Climate Forecast Applications in Bangladesh (CFAB) project (ADPC, 2004). CFAB was implemented from November 2000 till December 2003, with the involvement of the Program on Atmospheric and Oceanic Sciences (PAOS) at the University of Colorado/ Georgia Institute of Technology (GATECH), with assistance from the Asian Disaster Preparedness Center (ADPC), supported by the USAID Office of Foreign Disaster Assistance (USAID/OFDA). The PAOS/GATECH group was engaged in research aimed at increasing the lead-time of flood forecasting in Bangladesh, while ADPC identified broader forecast application opportunities and ways to institutionalize CFAB in Bangladesh.

2.1.1 Bangladesh

The Flood Forecasting and Warning Center (FFWC) of the Bangladesh Water Development Board (BWDB) is responsible for monitoring flooding in the country in a unified and multipurpose manner. Thirty (30) forecasting stations generate 24-, 48- and 72-hour forecasts everyday. A daily bulletin, based on observed data and results of forecast models, is prepared, and distributed at around 12:00 noon to various administrative tiers. The bulletin, mostly in tabular form, include the following: a) a cover page showing geographical, environmental settings of Bangladesh and location of all monitoring stations; b) river stage of all monitoring stations with respect to danger level, followed by rise/fall of water level on the respective date; c) rainfall situation for a specific date, followed by monthly normal and cumulative rainfall; d) summary of rainfall and river situation based on major findings; e) 24- and 48-hour forecasts for some important stations affected by shallow, moderate, and severe flooding[2]; f) flood warning messages that display trends of water levels (if close to or exceeds the danger levels, at which flooding becomes a serious threat); and g) a detail statistics on river stage and rainfall for three consecutive days.

The danger level nomenclature used by the FFWC may not be easily understood by potential users, as it does not relate the potential threat of floods on a specific crop at a specific stage and at a specific location, particularly in areas away from the main flood forecasting stations. The current flood forecasting arrangements provide 48-72 hours lead-time, which is sufficient only for undertaking emergency actions, but not for changing cropping patterns or modifying cropping practices to minimize agricultural losses due to floods. Thus, the intervention measures are still directed at rehabilitation of agricultural activities after the occurrence of floods. .

Analysis of the agricultural rehabilitation plan reveals the following limitations/ deficiencies:

- The timing of floods at the time of harvest not only leaves little time to complete harvest operations, but also leaves little time for resowing of the next crops.
- The loss of investment made in raising the damaged crop reduces the capacity of farmers to resow/ replant the next crop.
- The government, often, could not be in a position to mobilize assistance, such as supply of seeds and credit, to farmers for taking up the next alternate crops.

The above deficiencies led to a loss of 2 million tons of rice during the 1998 floods. The FFWC is currently implementing a pilot project, with NGO involvement, to evolve community-based flood forecast dissemination procedures that will meet users' needs.

2.1.2 Western Europe: The 1993 and 1995 Floods

The slow onset riverine floods in Belgium, Germany and the Netherlands in 1993 and 1995 provided considerable lead time. However, the scope and intensity of the 1993 floods came as a surprise to the Germans, Belgians and Dutch. Learning from this experience, they made proper use of the lead time granted by the gradual flood onset in 1995.

In both events, a wide variety of means of communication were used to warn the public. The difficult part was convincing the people of the genuine nature of impending danger. In some areas, the high frequency of flooding made the population believe in their own intimate knowledge of risks and dangers. Also, people were inclined to judge the flood warnings in accordance with earlier river flood experiences, which had been less severe. The 1993 floods, however, had a larger scope and impact, now

[2] Shallow or normal flood (depth is 50 cm below danger level): occurs during the months of April – May and submerges lowlands only.
Moderate flood (depth is within 50 cm above danger level): occurs between July – August and inundates low to lower middle lands.
Severe or deep flood (depth is more than 50 cm above danger level): occurs between July/August – September/October and submerges low/lower and upper middle lands.

estimated to be of once in a century frequency. It was therefore difficult to convince the population of the magnitude and severity of the coming flood.

Many people were not eager to evacuate – public shelter facilities remained almost empty. Some refused to evacuate because they felt adequately protected in the upper floors of their houses, as in previous events. Still, the governments were blamed for not taking necessary precautionary measures, and people demanded for damage compensation.

Though the countries have high quality flood detection and forecasting systems, problems with the forecasts and deficiencies in forecast communication were experienced. Many emergency services and authorities complained about the content and the timing of flood announcements, and the technical and non-transparent vocabulary used by meteorological and hydrological services. This eventually produced inter-organizational tensions between agencies responsible for the communication of river levels, and the responsible authorities and emergency services (Rosenthal and Bezuyen, 2000).

2.2 Extended Weather Scale

Global climate centers, such as the National Center for Environmental Protection (NCEP/USNOAA), Center for Ocean-Land-Atmosphere Studies (COLA), and the Climate Prediction Center of the US National Weather Service, provide extended range outlooks of precipitation and temperature 6-10 to 8-14 days into the future. The lead-time provided by these forecast products is sufficient for decisions to preserve livelihoods. However, these products have been available only in the last 5-6 years, and as such, application has not yet been institutionalized, although attempts to use in disaster management have been made. A survey of the applications thus far made would be worthwhile.

2.3 Sub-seasonal Scale

The experimental 20-25 day forecast developed by Dr. Peter Webster for Bangladesh will be further tested and its application demonstrated[3] in agriculture and disaster management in Bangladesh. The following application potentials have been identified:

- Rescheduling/postponement of seed broadcasting (deepwater *B. Aman* rice)/ transplanting (*Aman* rice)
- Undertaking mid-season corrections and crop life-saving measures wherever possible
- Reducing harvest/ storage losses
- Protection of young seedlings/ crops from flood
- Protective measures to save assets and livestock
- Enabling farmers to preserve investments and retain capacity to undertake next cropping
- Planning flood response activities
- Precautionary measures to protect infrastructure (e.g. growth centers, food silos, embankments, etc.)

2.4 Seasonal Scale

The breakthrough in the monitoring and prediction of ENSO in the last decade has significantly improved statistical efforts to relate El Niño to its climate effects. The climate predictability that ENSO provides, however, is still not being used optimally. The application potential of seasonal forecasts is

[3] These will be undertaken in the second phase of implementation of the CFAB program from 2004-2009, under the aegis of the Bangladesh Water Development Board. Dr. Peter Webster, and his team at the Georgia Institute of Technology, will provide the flood forecasts and transfer the forecast technology to Bangladeshi institutions, while ADPC will guide Bangladeshi institutions in the forecast application at the community level.

enormous, as it provides considerable lead time to modify decisions. Caution, however, is required in generating forecasts solely based on El Niño. Internal atmospheric processes operating independently of the El Niño have to be considered, as might be learned from China's 1999 flood forecast for the Yellow River (refer to following example).

The early prediction of the 1997-98 El Niño provided much early warning. However some countries, as may be gleaned from the following examples, had problems communicating the warning: lack of institutional mechanism to disseminate the forecast (China); urgency in disseminating the information to climate-sensitive sectors was lacking in Indonesia; warning was too general in terms of locations that will be most affected in the Philippines; lack of users' knowledge about the phenomenon and its impacts, which resulted to inappropriate actions (Australia); etc.

2.4.1 Australia

The Bureau of Meteorology (BoM) has been preparing seasonal climate outlooks each month for the past decade. Updated in the middle of the month for the following three month period, the outlook provides rainfall and seasonal average maximum and minimum temperature predictions in terms of chance or probability for all parts of Australia. The outlook is presented in a comprehensive booklet that includes maps and tables of rainfall and temperature probabilities in terciles: dry, wet and normal for rainfall; and cool, warm and normal for temperature. The outlook probabilities have been derived through a statistical analysis of the historical record and the Pacific and Indian sea-surface temperature patterns from 1949 to 1999. SOI analogues, recent seasonal rain, temperature and SOI observations, and frequency of media wet season rainfall are also included. The seasonal outlook, including outlook summaries for rainfall and temperature, is also available online at
http://www.bom.gov.au/silo/products/SClimate.shtml

Communication of seasonal forecast: August 1997 experience (Nicholls, 2000)

From May 1997, BoM has been including indication of a likely El Niño event, and hence an increased probability of low rainfall over eastern Australia. The outlook issued in early August 1997 indicated "El Niño persists: dry weather likely to continue over southeastern Australia". The summary went on to say "there is a strong likelihood of significantly drier than normal conditions persisting and expanding across much of eastern and southern Australia". The tables included in the August outlook indicated that rainfall in the dry tercile was, typically, two to three times more likely than the wet tercile. During the event, although there were areas where the August-October period was dry, there were also considerable areas with rainfall much above the average (and well into the "wet" tercile). Moreover, rainfall was good through much of the region in September, a critical time for crops.

A huge gap was noted in the communication, and hence understanding, of the forecast. Forecasters and users interpret certain critical words differently. To the forecasters, the word "likely" was intended to indicate that dry conditions were more probable than wet conditions, but there was still some chance that wet conditions would occur. Many users, however, interpreted "likely" as "almost certainly", such that weather that is predicted to be "likely dry" meant "almost certainly dry, and even if it wasn't dry, then it would certainly not be wet".

Lack of knowledge about interpreting and using ENSO forecasts caused many farmers to have inappropriate expectations of El Niño and took inappropriate actions to cope with it. As a result, the forecasts in some cases probably did more harm than good. It was reported that some farmers over-reacted and sold large portion of their herds, did not plant a crop, etc.

- Brazil
    - Ex. Brazil
        - Lesson1 – forecast agency tried to use probabilistic forecasts in cropping decision. Approach failed due to non-consideration of farmers knowledge of local conditions
        - Lesson 2 – forecast did not match requirement of the water resources sector (in terms of time scale)
        - Lesson 3 – relief is more attractive than forecast (politically) – therefore the need to demonstrate the value of the forecast before internalizing in the system

2.4.2 China: The 1998 Yangtze River Great Flood

The 1998 Great Flood in the Yangtze River was successfully predicted by the National Climate Center in the China Meteorological Administration (NCC/CMA). By including the ENSO signal in various forecasting models, the NCC/CMA predicted, as early as April 1998, above average rainfall for summer.

At the beginning of the summer of 1998, the subtropical high in the Northwestern Pacific was the strongest one on record. The convection band stayed stalled over the middle and lower reaches of the Yangtze River Basin starting in mid-June. Heavy rainstorms hit this area continuously. After June 28, the subtropical high moved to the west and shifted to the north. Rainfall in the middle and lower reaches of the Basin decreased, and the flooding of the Yangtze declined. In mid-July, the subtropical high moved back to the Basin, bringing with it continuous, strong precipitation processes for a second time. Compared to the first period, the rain area was smaller and the rain period was shorter. The rainfall, however, was heavier and formed downpours. Waters from Dongtin Lake, Poyang Lake and many small rivers constantly flowed into the Yangtze River, the water level of which, at that time, was still above the danger level. The water levels in the middle and lower reaches rose quickly and at the same time, flooding the whole basin.

In August, a succession of individual synoptic events at the upper reaches of the Yangtze led to five separate flood peaks (Ye et al, 2000). The forecasts of these peaks enabled the evacuation of more than 500,000 people and the cutting of major dykes to protect the city of Wuhan and areas downstream (Nicholls, 2001).

These floods demonstrate the importance of interactions between space and time scales: the large-scale climate anomalies led to a situation pre-disposed for flooding, but separate synoptic events caused the peaks in river heights. Forecasts on all time scales and space scales are therefore vital in mitigating disasters successfully.

<u>Lessons Learned</u>

Despite the early prediction of the event, over 3,000 people died. More than 15 million people were made homeless. Total damage exceeded US$ 20 billion. Ye et al (2000) reported that no government department responded to the initial forecast because:

- The forecast was not reliable enough; and
- Coordination between various government departments, committees, forecasters and policy makers was lacking.

The scientists were not trained to communicate with government agencies and the general public. The forecast information used scientific jargon that is not understandable by users. Users do not know how to deal with the uncertainties in climate forecasts.

There was no institutional mechanism for communicating climate information to various user departments and agencies. Had the agriculture agencies received the information, they could have arranged cropping strategies in anticipation of the event. Had the water conservancy departments obtained the information, they could have taken preventive actions in all potential flood zones, and damages could have been significantly reduced.

Since then, El Niño considerations have been included in seasonal climate prediction. Also, the government started to rethink the value of climate prediction in societal and economic development. The government invested an additional 300 million RMB (more than US$ 38 million) to evaluate the flood impacts and improve the scientific research facility within the CMA, and over 50 million RMB (over US$ 6 million) projects on climate variability were approved for the next five years (Ye et al, 2000).

Learning from the 1998 Yangtze experience, the government and the general public seriously took subsequent climate predictions. When CMA predicted that a big flood will occur in the Yellow River Basin in the spring and summer of 1999, the National Flood/Drought Prevention Committee acted quickly, and sent flood-resistant materials and undertook large-scale mitigation measures. The floods however did not come; rather, a prolonged drought occurred. Several millions RMB were lost due to the erroneous prediction.

2.4.3 Indonesia

Prior to 1997, the Bureau of Meteorology and Geophysics (BMG) used to issue weather forecasts keeping in view meteorological parameters. In 1997, the BMG established a broad-based National Seasonal Forecasting Working Group, drawing upon expertise from various sectors. This Working Group is comprised of the BMG, Agency for Assessment and Application of Technology (BPPT), the National Institute of Aeronautics and Space (LAPAN), Agriculture Research Institute, and Water Resources Management Institute. The Working Group draws upon forecast information from the ASEAN Specialized Meteorological Center (ASMC), the International Research Institute for Climate Prediction (IRI), BoM, and the UK Meteorological Office in preparing seasonal forecast guidance that includes the following for 102 meteorological regions across the country:

- Seasonal monsoon onset forecast with 10 day intervals, indicating the dates of onset of the monsoon
- Monthly rainfall forecast
- Seasonal cumulative rainfall status for the entire season

Respective climate sensitive organizations at the national level, on receipt of the climate forecast from BMG, process the outlook with reference to past impacts and disseminate the processed information to provincial sectoral organizations. This information is useful only for taking general precautionary measures, and cannot be used for comprehensive development planning. Information flow from field agencies to the national level user agencies activates only when disaster events occur.

Communication of seasonal forecast: El Niño 1997 experience

During 1997-98, the Ministry of Agriculture, on receipt of the information from BMG on the likely impact of El Niño, processed the information and disseminated it to provincial agencies in a routine manner:

Day 0: BMG press release of the seasonal forecast

Day 7-10: Official receipt of BMG forecast by the Ministry of Agriculture

Day 10-15: Ministry of Agriculture forwarded the information to the provincial agriculture extension services, indicating the potential impacts and the broad brush of contingency measures to be taken

Day 23-30: Receipt of communication by provincial agricultural services. The climate working team met for deliberations about the impending drought at the provincial level.

Day 30-40: Dissemination of information by provincial government to districts and sub-districts, with general recommendations about the need for taking possible actions

From the above, it took six weeks for the forecast information to reach the farmers with some general recommendations. By that time, farmers have already planted, on receipt of the first rains in September/October. The rains ceased thereafter. As a result, about 500,00 ha of crop area was affected by drought (Boer, 2001). As no concerted effort was taken to make use of the lead time provided by the ENSO forecast, a loss of around 3 million tons of rice was reported. The Government had to import about 5 million tons of food grain to ensure the country's food security.

2.4.4 Philippines

The first season ahead forecast by the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) for the agriculture sector was issued in January 1985. This was a result of the capacity building initiative from the US National Oceanic and Atmospheric Administration (NOAA) on Agroclimatic Modeling and Impact Assessment Technology Transfer to Southeast Asia. The incorporation of ENSO indices in the seasonal forecast was first made in 1987 at the height of the 1986-87 El Niño, based on a study by Jose (1986) which confirmed the association of major drought events in the country with El Niño episodes. On the same year, the Drought Early Warning and Monitoring System, now known as the National ENSO Early Warning and Monitoring System (NEEWMS), was established to provide seasonal forecasts and timely advisories to various end users, particularly policy and decision makers, economic planners and emergency managers. The NEEWMS is now part of the Climate Information, Monitoring and Prediction Services (CLIMPS), which includes the early warning system, provision of monthly weather outlook to member agencies of the Inter-Agency Committee for Water Crisis Management (a committee created to address the need for judicious and effective management of water resources in the country), and the conduct of briefings/ seminars on El Niño, its impacts on climate-dependent sectors in the country's 14 administrative regions, and services provided by PAGASA to mitigate the negative and enhance the positive impacts (Amadore et al, 2002). Figure __ shows how global forecasts are tailored to fit end user requirements.

The NEEWMS uses observations from a network of 50 surface synoptic weather monitoring stations and 40-year historical data sets of 10-day and monthly rainfall. Information provided to government agencies and, upon request, non-government organizations, include: rainfall analysis, 10-day, monthly, seasonal and 12-month rainfall accumulation (presented as a percentage of normal, percentile rank (Table 1) or actual values) for each administrative region for rainfall abnormality assessment; derived indices (moisture availability, yield moisture, generalized moisture, and rainfall extreme indices) for monitoring extent and impact of rainfall abnormalities; and monthly and seasonal weather advisories.

Downscaling

In the absence of an appropriate regional or climate numerical model for the Philippines, PAGASA translates ENSO forecasts from international climate centers to local conditions. Potential impacts on local climate is predicted by analogy, using time series El Niño and La Niña indicators and their historical impacts on various sectors.

Current efforts are underway to provide statistically downscaled climate information through the USAID/OFDA supported program on Climate Forecast Applications (CFA) for Disaster Mitigation in the Philippines, implemented by the Asian Disaster Preparedness Center in collaboration with the International Research Institute for Climate Prediction (IRI).

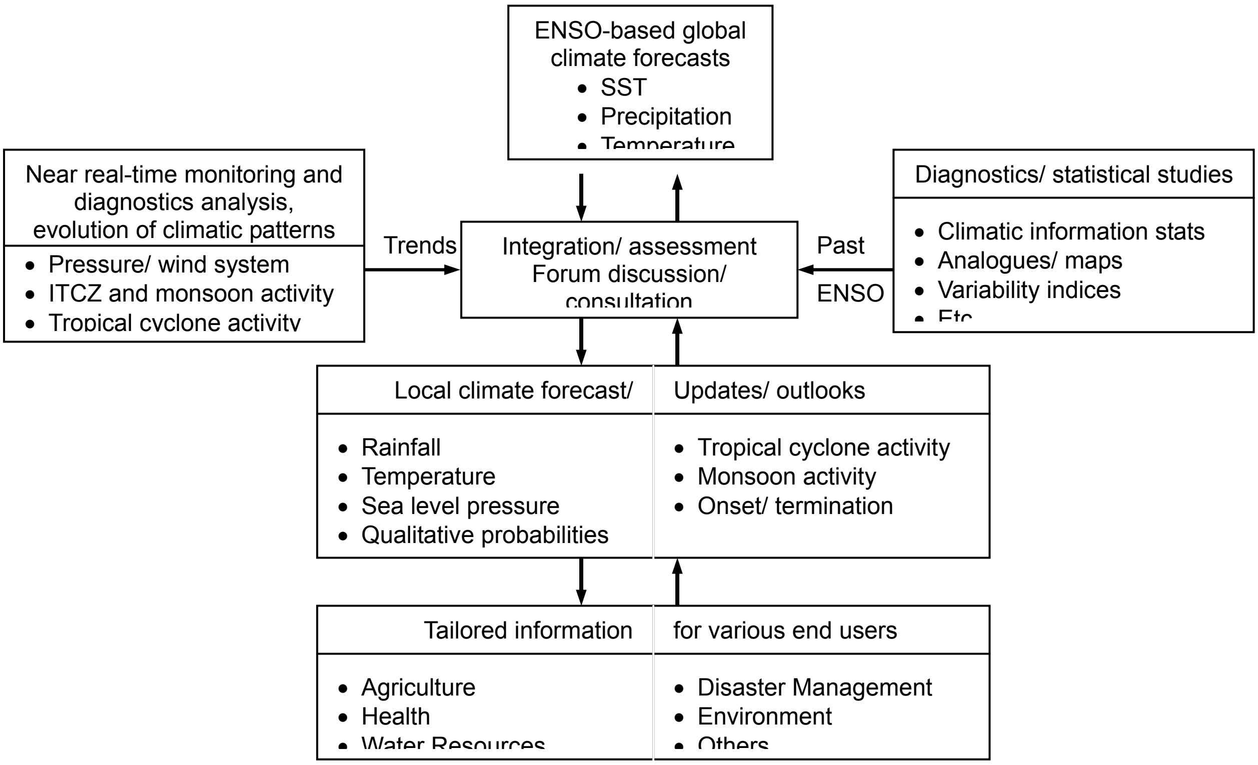

Figure ___. Translation of ENSO-based global climate forecasts into local climate forecast

Table 1. Interpretation of rainfall accumulation

Percentile Rank	Interpretation
>90	Severe flood damage
81-90	Potential flood damage
61-80	Way above normal rainfall condition
41-60	Near normal to above normal rainfall condition
21-40	Below normal rainfall condition
11-20	Potential drought impact
≤ 10	Severe drought impact

Source: Amadore et al, 2002

<u>*Communication of the 1997 Seasonal Forecasts*</u>

PAGASA issued its first El Niño forecast at the end of the last quarter of 1995, hinting the potential occurrence of an El Niño in the succeeding seasons. In March 1997, it announced the onset of El Niño 1997-98. Local rainfall and general circulation patterns were intensively monitored. Drought advisories were issued, the first advisory in May 1997, indicating the broad weather outlook. Below is an extract of the seasonal climate forecast issued by PAGASA in May 1997:

> Based on the recent evolution and forecast of the atmospheric and oceanic conditions, it can be expected that warm episode will intensify during the next several months. This climate forecast on an impending warm episode will have global scale implications and, for Philippines, some climate tendencies during the seasons are indicated below:
>
> *Southwest monsoon season (May 1997 – September 1997):* In view of this new development, the onset of the rainy season (which normally occurs during the second half of May) is expected to be delayed by about two weeks. With this, the duration of the rainy season, which normally ends during the early half of October, may be short ended, although some bursts of heavy rainfall during the rainy season could also be expected mostly in the western section of Luzon and some parts of western Visayas.
>
> *Northeast monsoon season (October 1997 – March 1998):* The impending warm episode in the central and eastern equatorial Pacific will have influence on the activity of tropical cyclones in the Philippine Area of Responsibility (PAR). Below normal tropical cyclone activity will most likely occur during the coming northeast monsoon months. This will cause below normal rainfall condition in a bigger portion of the country.

The relevant extract of the drought advisory issued by PAGASA before the commencement of the northeast monsoon 1997-98 is given below:

> Based on trends, climatological studies and the present atmospheric and oceanographic situation in the central and eastern equatorial Pacific, manifestations of the effects of the existing El Niño phenomenon on the Philippine climate will have its peak during the northeast monsoon season (October to March). Atmospheric sea level pressure in the eastern equatorial Pacific, including the Philippines, will be above the normal, while sea surface temperature will be below the normal. Consequently, below normal tropical cyclone activity is expected in the PAR. With these factors, drier than normal weather conditions can be experienced in the Philippines starting October 1997, and continuing through March 1998.

The expressions such as “drier than normal weather conditions” and “bigger portion of the Philippines would experience moderate to severe drought” was interpreted by user departments as that the whole of Philippines would be affected by a devastating drought. The Department of Agriculture organized an El Niño Summit in July 1997, attended by all concerned line agencies, and the Office of the President of the Philippines created the inter-agency El Niño Task Force[4] in September 1997. Resources were distributed to all the regions of the country.

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[4] The Task Force is chaired by the Secretaries of the Departments of Environment and Natural Resources, and Agriculture (DA), with the following as members: Department of National Defense (DND); National Disaster Coordinating Council (NDCC); the Departments of Transportation and Communication (DOTC), Interior and Local Government (DILG), Energy (DOE), Science and Technology (DOST); Presidential Management Staff (PMS); National Irrigation Administration; PAGASA; and the Philippine Crop Insurance Company (PCIC).

The drought impact was confined to certain areas only. Farmers did not get the location-specific advisories, for changing crops, etc. As such, around 600,000 ha of corn and rice lands were affected by drought.

- Ex. South Africa – Lesson: global impacts do not manifest locally, therefore caution is needed

3. Issues and Challenges

The current skill in climate prediction, though imperfect, offers considerable opportunities to managers in reducing risks to climate-related hazards, and to reap benefits from a good climate. Climate information, effectively communicated and applied, should lead to a change in decision that generates improved outcomes in the system of interest. This involves the following elements: the message to be communicated – climate prediction and interpretation into local climate outlook; the communication of the message – translation, message construction and dissemination; the receipt of and response to the message; and a feedback mechanism – examining the various aspects of the system with a view to improve its performance. Interrelations of these elements are illustrated in Figure __.

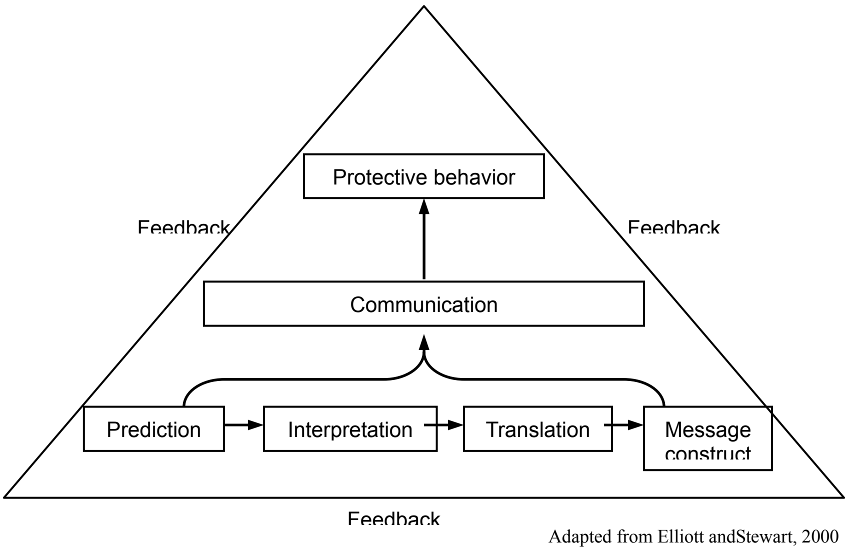


Figure __ The warning system

The above elements need to be integrated, rather than operating in isolation from each other. At-risk communities need to be involved in the design of the system. The biggest challenge in achieving this integration is coordination of the various agencies within different government levels tasked in each of these components, as each agency has its own administrative system with jurisdictional boundaries, different organizational cultures and priorities, in addition to the different technologies used. The roles of each agency, therefore, should be clearly identified, and each should accept ownership of the system.

3.1 Climate Prediction and Interpretation into Local Climate Outlook

3.1.1. Weather Forecasts

Despite technological advances in monitoring and prediction, hurricane track forecasting remains an inexact science. Current forecast models still produce a wide margin of error: an average of 146 km for a 24-hour forecast (Nicholls, 2001). Tornados are even more difficult to predict, as it forms and decays in about 12 hours.

3.1.2. Seasonal Forecasts

Delimitation of ENSO Sensitive Sectors, Seasons and Regions

Climate exhibits only limited predictability, and skilful forecasts are available only for some seasons and regions. While there are clear relationships between ENSO indices and local climate variables in some areas, other areas do not exhibit a linear relationship. It would take some time to obtain climate forecast with greater geographic resolution, covering all factors governing climate variability. It is therefore necessary to delimit specific climate sensitive zones, which are highly sensitive to ENSO indices, and where specific relationship exists between ENSO indices and local climate variability (as compared to other areas). After spatial delimitation of geographic zones, a temporal delimitation of a comparatively more ENSO sensitive season than other time periods needs to be undertaken. For instance, the summer season is more sensitive to ENSO than the dry season, which is by and large protected by assured irrigation systems. Forecasting efforts can then focus on these ENSO sensitive regions and seasons for particular sectors. This would facilitate the application of climate information at the local level.

Study on dynamics of ENSO Influences on Climate

Climate is a complex system. Physical mechanisms of many climate phenomena, such as ENSO are not yet fully understood. There is a need for further research on how ENSO influences the local climate, including other climatic parameters and modes of atmospheric variability, such as the Quasi-Biennial Oscillation, Madden Julian Oscillation, etc.

Integration of Intra-Seasonal Oscillations

The seasonal forecast would provide an indication of the rainfall behavior during the course of the season. Meso-scale intra-seasonal oscillations, however, may result in long dry spells, cyclones and storms. Farmers will encounter these disturbances in the course of the cropping season. Certain mid-term corrections are therefore necessary to minimize crop yield losses. The sub-seasonal and extended weather forecasts should provide the critical information for undertaking corrective measures.

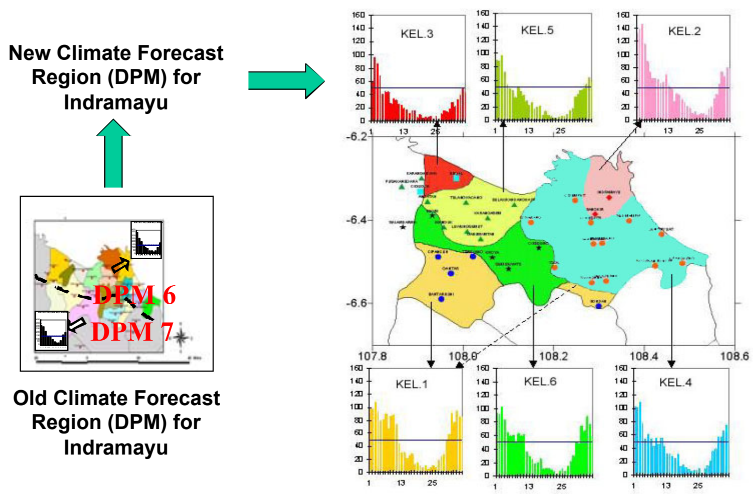
Downscaling of Climate Forecasts

Currently available seasonal forecasts are at too large a scale to be useful for site level planning. Both spatial and temporal scales need to be refined for local application, hence the need to downscale the global ENSO index-based forecast into local level climate outlook products (interpretation of global climate outlook into local climate outlook). This would also entail building technical capability for downscaling within the NMSs.

Box 1
Delivery of Locally Relevant Climate Information: Indonesia Experience

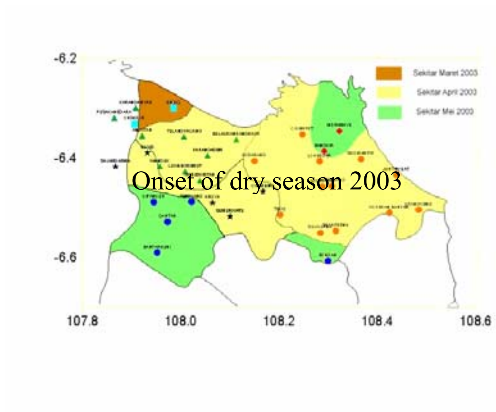
BMG used to release monthly and seasonal forecasts, which may have not matched users' needs and time requirements for climate information. This has now changed to releasing forecasts that are relevant to the lead-time requirements of the end users.

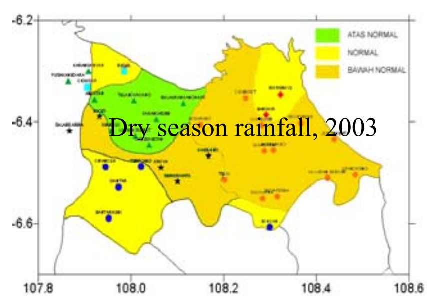
Based on the user's need survey and vulnerability assessments, BMG have refined the seasonal forecast product for Indramayu District in West Java, by establishing six forecast regions in place of the existing two regions. The new six regions reflect six different local climatic zones (refer to figure below). This refinement helped BMG to provide locally relevant climate forecast information to the farmers in pilot locations.



Modified climate zone map of Indramayu District, West Java, Indonesia

Localized forecast and impact information were first delivered in March 2003, on which farmers based their decisions to modify crop calendars (see figures below).





Articulation of Users' Needs

Most research has been driven from the climate and agro-ecological communities, and has tended to involve a top-down approach, where uses are sought for existing forecast products, and less commonly by a bottom-up approach, where a decision situation is examined to identify niches and needs for climate information. Also, most current forecast products lack the spatial, temporal and element specificity that users seek for their specific decision-making needs. Users are diverse, and cannot be lumped into a homogeneous set. For example, in the agriculture sector, the needs of agribusiness, such as seed suppliers and grain traders, vary distinctly from primary producers. Among producers, limitations in access to resources, or risk exposure, condition responses to new information; for suppliers and traders, it is profit maximization.

User inputs to the prediction system are necessary to ensure that the climate information is relevant to the users' needs – what type of information is needed when, to assure its utility in resource management and risk reduction.

Suite of Forecast Products

Seasonal forecasts need to be complemented by sub-seasonal and weather forecasts closer to the event as more hydrometeorological data become available.

Box 2
Overlapping Flood Forecasting System for Bangladesh

Climate Forecast Applications in Bangladesh (CFAB) has developed a three-tier, overlapping forecast system, which significantly improved the lead times of forecasts issued by the FFWC and the Bangladesh Meteorological Department. This includes:

1) Short-range forecasts of rainfall and river discharge in probabilistic form, provided each day, with 6-10 days lead-time;
2) Medium-range forecasts of average 5-day rainfall and river discharge, updated every 5 days, with 20-30 days lead-time; and
3) Seasonal outlook starting at the beginning of the monsoon season and updated each month, providing 1-6 months lead-time.

These forecasts, still at en experimental stage, are potential risk management

3.2 Communication of Climate Information

Application examples given in the previous section point to user difficulties in understanding climate information issued by NMSs. There is a need to further process the local climate outlook to a form that is readily usable by farmers and other end users. In Bangladesh, farmers would like to see the message communicated as follows:

> Dear Villagers,
> Asalamalaikum. As per the news we have heard in the ……, the water of Jamuna River is likely to run at a very high level in the next 10 days. Based on the information provided by Block supervising officers, it is likely that the following fields …… will be inundated fully in the next few days. You are all requested to harvest your crops immediately, and withhold seedbed operations for 10 more days. Please watch the flood post established in the village.

3.2.1 Translation of Climate Outlook into Impact Scenarios and Response Options

Predictions need to be given meaning, if they are to be understood and guide responses by users. The local climate outlook needs to be translated into impact scenarios, keeping in view specific vulnerabilities at the local level with reference to different seasons and different cropping systems. Response options can then be drawn, considering socio-cultural peculiarities, for communication to the user community. This is a role that intermediary institutions can play.

Philippine experience

3.2.2 Risk Communication

Understanding the warning message is key to community response. An effective warning should inform:

- what is happening
- what it means to the person; and
- what the person can do

The example from farmers given above reflects these three requirements.

Additional criteria include:

- Language should be clear and simple; avoid using jargon
- It should satisfy psychological needs (e.g. suggest action rather than inaction; be positive rather than negative). Simple changes in phrasing of forecasts could lead to substantial changes in their use (e.g. a drought forecast may be expressed in terms of non-likelihood of wet conditions, rather than in terms of likelihood of drought).

It is also important to note that people's perception of risk associated with a forecasted event is often anchored to their most recent experience. A communication strategy needs to be developed so that people do not over- or underestimate the risks.

3.2.3 Mode of Communication

Weather forecasts are usually communicated via print and broadcast (radio and television) media. An emerging medium is by mobile phones through text messaging (SMS). At the community level, dissemination is varied, from two-way radios, to public address systems, loudspeakers, sirens, door knocking, community networks, and community leaders. Complementary modes of delivery (e.g. radio, community network and door knocking) should be considered, given ample time, depending on the severity of the hazard and the required response.

For seasonal forecasts, community meetings are effective venues for dissemination, as it provides interaction with the local meteorologist and extension workers. Community fairs work for remote areas where households are kilometers apart.

climate field school

3.3 Response to the Message

3.3.1 Weather Forecasts

Garcia (2002) identified the following requirements for an effective community response to warnings:

- Getting free warning and hazard information
- Receiving warning with sufficient lead time

- Understanding the warning content
- Believing the warning
- Believing that the threat is real
- Knowing when and what appropriate action to take
- Being in a state of preparedness

Getting people to appropriately respond to a warning is a critical component of an effective warning system. The death of 139,000 people in the 1991 cyclone in Bangladesh was attributed to people who did not believe the warning and those who refused to leave to guard their properties (Baker, 2002).

Communities need to be involved in relating the warning to danger to lives and property. Continued education and public awareness would be necessary.

- Gaps – seasonal forecasts
  - Bring in Table IV p190 – seasonal forecasting for climate hazards – important: high skill, high utility

- Bring in diagram (p11 Lessons from 1997-98 El Nino; Fig 2.3 p12)

3.3.2 Seasonal forecasts

Detailed interactions with farmers show that probabilistic forecasts are acceptable in vulnerable areas. Table 2 shows the acceptability of probabilistic forecasts by farmers in various risk-prone areas in Bangladesh.

Table 2. Acceptance of probabilistic forecasts by various categories of farmers in risk-prone regions

Farmer category	High flood/drought-risk area	Medium flood/drought-risk area	Low flood/drought-risk area
High risk-taking farmers	High acceptance of probabilistic forecast indicating slight shifts of climate/flood situation. Acceptable forecast: 50-60% probability	Moderate acceptance of probabilistic forecast indicating moderate shifts of climate/flood situation. Acceptable forecast: 60-70% probability	Low acceptance of probabilistic forecast indicating decisive shifts of climate/flood situation. Acceptable forecast: More than 80% probability
Risk-neutral farmers	Moderate acceptance of probabilistic forecast indicating moderate shifts of climate/flood situation. Acceptable forecast: 60-70% probability	Low acceptance of probabilistic forecast indicating decisive shifts of climate/flood situation. Acceptable forecast: More than 80% probability	Acceptable forecast: Deterministic forecast
Risk-averse farmers	Low acceptance of probabilistic forecast indicating decisive shifts of climate/flood situation. Acceptable forecast: More than 80% probability	Acceptable forecast: Deterministic forecast	Acceptable forecast: Deterministic forecast

Discussions with farmers revealed that they could deal with probabilistic forecasts in the following manner:

- They understand the probabilities in various ways, based on their life experiences. They also understand the uncertainties inherent in the future state of the climate by relating to their experiences in various indigenous games and sports.
- They could relate probabilistic forecasts, which are of qualitative nature, to a micro-level situation, based on past experiences of floods/ adverse climate of various dimensions.
- Farmers operate on season-to-season basis. They relate probabilistic forecasts with reference to its relevance to a particular season. They view that if the forecasts are correct in 7 out of 10 seasons, the benefits due to correct forecasts could outweigh the losses that they may have to bear due to decisions based on three incorrect forecasts.
- Confidence in probabilistic forecasts is increased by correct forecasts in two consecutive seasons.
- The communication of uncertainties inherent in the forecast could give them opportunities to appreciate the dimensions of forecast constraints, and undertake "no regret options".
- A continuous two-way communication between forecast producers and users, for at least 5 years (10 seasons) could help them establish trust and confidence.

Farmers, however, have the following constraints in responding to forecasts:

- Lack of credit access or previous debt burden
- Limited access to ploughs, seed of suitable varieties, and other inputs
- Limited land access
- Competing demands for labor
- Inappropriate forecast information
- Lack of confidence in the forecast, or in the source/ provider of the information
- Untimely dissemination of forecasts
- Priorities and strategies for risk aversion and risk management
- Decision irreversibility
- Market access or stability of prices and demand for cash crops
- Local consumption preferences for crop varieties
- Diversity and level of income, both on- and off-farm

There is a need to evolve policies and programs at the national level to address these constraints, to enable farmers to use climate information.

3.4 Feedback Mechanism

Feedback provides an opportunity for system improvement. This will normally be after an event or after a season, and will include assessment of the performance of the different components of the warning system. Other opportunities for review include technological changes as they influence prediction and interpretation, and environmental changes as they affect translation (e.g. development impact on the environment that contributes to vulnerability).

Even if the system has not been activated for some time, especially in countries/ locations where there is a big gap between events, reviews are useful for reminding stakeholders of their roles in the warning system, to compensate for staff turnover and other organizational changes, as well as review the state of preparedness of the community. For tropical cyclones, Parker (1999) has laid out criteria for evaluating the warning system status.

3.5 Institutionalization of the End-to-end System

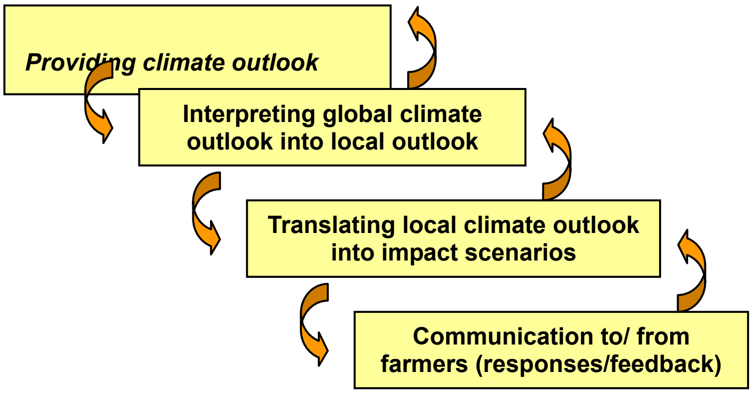


Figure __. End-to-end climate information generation and application system

The above end-to-end system connects the climate information provider, the intermediary user agencies, and the user community.

In the 1970s, the large losses of lives from tropical cyclones in Bangladesh and India have been attributed to the failure of warnings to reach the population at risk (Baker, 2000). Improvement in early warning systems, particularly in dissemination, and public awareness and understanding, has greatly contributed to the remarkable decrease in deaths associated with cyclones.

To address these issues:

- set up institutional systems (feature experiences of CFA;)

4. Integrating Climate Information in Development Planning

Disasters induce change. Each milestone in the long history of institutionalized disaster management in countries that face recurring disasters, more often, came about in response to a major event that is often costly in terms of lives and properties lost. In the Philippines, the formulation of the Disaster and Calamities Plan was in response to Typhoon Sening that ravaged the Bicol Region and flooded Metro Manila in 1970 (ADPC, 2001). In Bangladesh, the integrated Flood Action Plan was developed in response to the consecutive major floods in 1987 and 1988.

For many years, governments' responses to disasters were reactionary, hence the focus on response, relief and rehabilitation. The United Nations International Decade for Natural Disaster Reduction (1990-2000), with an aim to reduce loss of life, damage to property, and social and economic disruption caused by natural disasters, particularly in developing countries, pushed a disaster mitigation agenda. Within this period, a shift in disaster management paradigm occurred, that from being reactionary to anticipatory; hence a shift in focus from response, relief and rehabilitation to prevention, mitigation and preparedness.

In 1991, the Philippine government realized the significance of disaster mitigation in achieving sustainable development, and started integrating this component into the Medium Term Philippine Development under the Development Sector Administration. At the local government level, provinces, cities, municipalities and barangays were required to integrate their disaster management plans into their respective local development plans (Duque, 1999).

The IPCC Third Assessment Report (2001), in its summary for policymakers states that human influences will continue to change atmospheric composition throughout the 21st century. As a result global average temperature and seal level rise are projected to rise under all IPCC scenarios. Under this warming scenario, it is likely that Asian summer monsoon precipitation variability will increase. The projections also stated a likelihood of increase in the tropical cyclone mean and peak precipitation intensities. That is developing countries in Asia which are currently very vulnerable to current extremes in the atmospheric and hydrological cycles are likely to have these vulnerabilities exacerbated in the future. Hence building adaptive capacity to such vulnerabilities should be given priority. More importantly, further understanding on the changes in the extremes under a warming climate should be given priority.

Yet another shift in paradigm has recently taken place, which looks at disaster management in a risk management framework. In 2002, Bangladesh formulated the Comprehensive Disaster Management Programme (CDMP), which integrated risk management into development planning. The CDMP recognizes the risks associated with climate variability and change, and the current need to build capacity in assessing and managing long-term climate risks in the country.

In countries that have seldom experienced disastrous events, or where the interval between major events is quite long, climate risks are not factored in their development activities. More……

Science has and continues to contribute to this effort of reducing losses due to natural disasters. It has come a long way in providing usable climate information at various time scales. The science of climate prediction is not perfect, but it is evolving. Now is the time to integrate this information in development planning.

--Bringing Science To Society

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